REPORT

OF THE SPECIAL STUDY TEAM

ON THE FLORIDA EVERGLADES

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George W. Cornwell
Associate Professor of
Wildlife Management
University of Florida
Gainesville, Florida

Robert L. Downing
Wildlife Research Biologist
U. S. Bureau of Sport
Fisheries and Wildlife
Blacksburg, Virginia

Arthur R. Marshall
Director, Laboratory for
Estuarine Research
Institute of Marine Science
University of Miami
Miami, Florida

James N. Layne
Director of Research, Archbold
Expeditions of the American
Museum of Natural History
Lake Placid, Florida

Charles M. Loveless, Chairman
Assistant Director, Denver Wildlife
Research Center
U. S. Bureau of Sport
Fisheries and Wildlife
Denver, Colorado

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INTRODUCTION[1]

The Florida Everglades is one of the most unique and perhaps most interesting natural ecosystems in the world. For at least the past 20 years ecologists and conservationists have voiced their concern about the future of this vast marsh-swamp complex. Certainly the sometime lonely persons espousing their views through the years have helped to create a new public awareness. This awareness has developed primarily, however, because people are beginning to see evidence that what is happening can have a visible impact on their well-being.

Interest in the area obviously extends beyond the State of Florida. Controversy over the water supply to Everglades National Park, the proposed Big Cypress Swamp jetport construction, and the die-off of deer in the Everglades has brought the environmental problems of southern Florida into sharp focus on a national scale. Primarily because of the deer problem, a study team was appointed by the Florida Chapter of the

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[1]The views and recommendations in this report are based on the findings, experiences, and professional opinions of the individual study team members, and do not necessarily reflect the views or policies of their employing agencies and institutions.

Wildlife Society in late March 1970 at the request of the Central and Southern Florida Flood Control District and agreed to by the Florida Game and Fresh Water Fish Commission. The mission of the team was to evaluate the current wildlife situation in the Everglades, insofar as possible, and suggest some possible courses of action.

The study team consisted of five members representing a wide range of experience and disciplines, and at least 25 years of intimate association with the Everglades. Nonetheless, we also called upon about 25 of the most knowledgeable people in south Florida for consultation on the overall Everglades problem. In addition, we freely utilized information contained in numerous documents, letters, publications, and special reports made available to us. We have made every effort to deal objectively with the great ecological, economic, and social values of the total Everglades ecosystem and the importance of preserving what remains of this environment in its natural state. We have been keenly aware of the tremendously diverse and complex demands which are constantly made on the natural resource base in the Everglades.

In order to put the problem into better perspective it is essential to briefly describe the Everglades-Okeechobee Basin and other related natural features of Florida.

The most characteristic climatic feature of the Everglades is its great seasonal variation in rainfall. Owing both to the nature of the topography and widely fluctuating rainfall cycles, the area is frequently subjected to extremes of extensive flooding or drought. Mean annual precipitation in the Everglades is 55 to 65 inches but about 75 percent of

this occurs from May through October. During dry periods, however, annual precipitation may be 35 inches or less; in wet years 120 inches or more has been recorded. Slight variations in average rainfall and temperature conditions have a relatively insignificant effect on the indigenous fauna and flora and in themselves do not account for the great differences in vegetation and flood and drought.

The Everglades system begins in the so-called "Chain-of-Lakes" of the upper Kissimmee River Basin in central Florida which has historically drained south via the broad Kissimmee marshes to flow into Lake Okeechobee. During the rainy season, Okeechobee at times overflowed its southern rim into the sawgrass Everglades with the shallow sheet of water slowly moving southwestward to the mangrove swamps at the tip of the state and into Florida Bay and the Gulf of Mexico. In a seasonal cycle of winter and spring dryness and heavy summer rains, the entire basin has been alternately wet and dry. This cycle has undoubtedly always been highly variable but historically it has been a long and slow attenuated process, resulting in the evolution of complexes of animal and plant species whose life cycles are adapted to such environmental regimes. These include the sunfishes of the fresh water portions; numerous mammals, including deer; the colonial nesting and wading birds of the region; the turtles, frogs, snakes, and alligators; a host of invertebrate species; many marine fishes and shellfishes of the coastal waters; and the ubiquitous sawgrass, water lily, spikerush, and willow. Thus, the hydroperiod is the principal factor which has influenced the evolution of the Everglades ecosystem and is the key to its continued existence.

Over the years, man has made dramatic changes in the Everglades, beginning with modest drainage efforts in the 1890's and continuing to the present with the extensive effort which comprises the operations of the U. S. Army Corps of Engineers and the Central and Southern Florida Flood Control District. All of these activities have greatly reduced the extent of the original flood plain of the Everglades Basin and the natural functioning of the ecosystem. By reducing the extent of the original Basin, and utilizing the deeper portions to a greater degree, a condition has been created in which water level changes occur with greater rapidity.

The study team recognizes, however, that benefits to people have resulted. The project works have made vast areas in the Kissimmee Basin and in the area south of Okeechobee available for agricultural uses. Former wetlands have also been opened to urban and industrial development, and the severity and frequency of floods in these areas have been reduced. Yet, along with these benefits many problems have arisen. According to 1969 reports of the U. S. Army Corps of Engineers to the U. S. Congress, south Florida faces critical water shortages by 1976 unless all previously authorized works are complete and a significant start is made on a newly authorized $78 million addition. This factor alone is cause for considerable apprehension concerning the proposed Big Cypress Swamp jetport construction because such construction would produce more drainage from the same basin while increasing the demand for water, an obvious worsening of the water supply-demand situation.

The study team is aware of the great significance of the Everglades to the welfare of human populations in south Florida. The marsh and

associated habitats function as a major recharge area for the Biscayne aquifer upon which the Gold Coast population centers mainly depend for their water. In addition, the richness of the fauna of Florida Bay as well as other estuarine areas is ultimately dependent upon the Everglades ecosystem.

The great muck deposits south of Lake Okeechobee, the site of a giant agricultural industry, are the product of sawgrass and other aquatic plants living and dying there for more than 5,000 years. The marine fisheries of at least the upper third of the Florida Keys, for example, like the shrimp fishery of the Tortugas, are greatly dependent upon the natural functioning of the Everglades. It follows that the overriding concern should be the preservation of this unique ecosystem, and one of the principal objectives of water management in south Florida should be to restore as closely as possible the original natural hydroperiod. So long as the Everglades is a viable, dynamic environment the Gold Coast will also be viable and dynamic.

Everglades National Park is itself a great national resource enjoyed by millions from throughout this nation and abroad. The portion of the system outside the Park also provides outstanding aesthetic and outdoor recreational opportunities for both tourists and residents of the state. The major, and perhaps most typical, part of the true Everglades marsh lies outside the Park, however, chiefly in Conservation Area 3, and is not at present as well protected as that in the Park. Therefore, alternative courses of action, e.g., wild or primitive area status, etc., including jurisdictional legislative authorities, should be fully explored

that would provide needed protection to all or portions of this ecologically unique region of the Everglades.

Although water level manipulation in Conservation Areas 1 and 2 has caused changes to a greater degree than other portions of the marsh, these areas are an integral part of the total Everglades ecosystem and must be included in any overall consideration of the environmental complex. Similarly, the Big Cypress Swamp is an integral portion on which great wildlife, recreation, and water conservation assets depend.

There are no simple answers to the many problems which beset the Everglades. The entire question is extremely complex and will take much study and thought for solution. New, and undoubtedly difficult, decisions must be made on priority and balanced uses of the natural resource base. Irrespective of what these decisions are, they will not be universally acceptable to everyone.

In the long view there is no basic conflict between the needs of man and the needs of the ecosystem. Solutions to water problems in south Florida should strike an optimum balance between these various needs including conditions necessary for maintaining not only a healthy ecosystem, but also the interests of agriculture, recreation, and urban water supplies. It is apparent that this will involve some hard decisions on the part of agency administrators, e.g., setting an upper limit to human population growth in the region and acceptance by the agricultural- and recreation-use sector of losses during years of both drought and high water. The natural ecosystem averages its losses from periodic occurrences of unusually adverse conditions and there is no reason why

this principle should not apply to agriculturalists as well as other interests operating within the environmental system.

Any problem concerning water relationships in the Everglades, whether it involves the whole system or a single part, must be treated from the standpoint of the entire drainage system extending from the headwaters of the Kissimmee River to Florida Bay. Even though this natural basin has been severely compartmentalized by levees and endlessly dissected by canals, drastically altering original flow patterns and rates, the major components are still essentially interconnected. What happens in one part influences what happens elsewhere.

Thus, the area of the study team's concern has been the total Everglades system. Management of individual species populations within a local area, or over the entire region, must be compatible with the primary objective of preserving the integrity of the whole system. Any consideration for individual species, such as deer, must be viewed in the context of the total problem.

WATER QUANTITY AND QUALITY

Based on present project planning, increasingly serious problems of water quality and quantity in the Everglades ecosystem may be expected. Although some similarity to the original wet-dry, hydroperiod cycle under the present water management scheme is still evident, low water conditions and rates of water level changes are more accentuated now than they were under natural conditions in the past. These factors in themselves are having a great ecological impact on the entire Everglades as evidenced by changes in the vegetation and in population numbers of certain species

of vertebrates. Reductions in animal numbers, or shifts in their distribution, are often symptomatic of environmental change or degradation. Previous experience has shown that changes in vertebrate populations are one of the most effective early warning indicators of a deteriorating or changing ecosystem.

Time does not permit, nor is it within the purview of the study team, to undertake a detailed analysis of past water level records in the Everglades. It appears, however, that in recent years water levels have been maintained in the Conservation Areas at higher levels than they were during the early decades of this century.

The entire question of water regulation scheduling for the Conservation Areas should be completely reevaluated to determine applicability in terms of current priorities and objectives. Such reevaluation should be a continuous process. If it is shown that current schedules are not now appropriate, then new ones should be developed in the most intelligent and objective manner possible, using all available data. Once they are established every effort should be made to adhere to them.

It is the understanding of the team that the water level in Conservation Area 3 has been essentially above schedule for many months. Determining whether the schedule in Area 3 is, or has been, above schedule seemingly depends, in part at least, on which gauges are used to compute mean levels. For example, on May 26, 1970 all gauges in Area 3 were read on the same day. The water regulation schedule for May 26 called for 9.54' msl. On May 27, gauges 3-3, 3-4, and 3-28, the gauges used by FCD as a guide to the mean water level for Area 3, averaged 9.71', or

0.17' msl above regulation. However, the so-called deer gauge, 3-2, read 11.40' msl on this same date indicating that at this gauge the water level was 1.86' above regulation. If the 3-2 gauge is included with the 3-3, 3-4, and 3-28 gauges, the mean is 10.14' as contrasted with 9.71' when it is not included. In other words, by using the deer gauge to compute the mean level, it was 0.60' above regulation on May 26 as contrasted with 0.17' above regulation based on the 3-3, 3-4, and the 3-28 gauges alone.

In Conservation Area 1, guidelines to water level regulation is determined by the Corps and the FCD by using gauge 1-8T, a remote sensing gauge located in a slough about 500 to 600 yards west of the boat landing at the Refuge headquarters. The Refuge, however, is using gauge 1-8 located in the L-40 canal at the headquarters landing. On April 30, 1970, gauge 1-8T read 15.4' msl while at the same time a little over 1/4 mile to the east gauge 1-8 in the canal read 13.87' msl. The reason for this difference is that gauge 1-8T is located in the interior marsh where low natural berms, tree islands, and vegetation impede the movement of surface water eastward toward the L-40 canal once the level has dropped below the 15.0' to 15.5' msl mark on gauge 1-8 in the canal. Water can continue to be lowered in the canal while gauge 1-8T levels off to 15.5'. Ground level at gauge 1-8T is listed as 15.2' msl. Thus, it is not possible to reach the 15.0' msl as shown on the schedule.

The Army Corps of Engineers and the FCD, by using gauge 1-8T, get a reading for the interior marsh. Somewhere between 15.0' and 15.5' msl

the water surface is continuous between gauges 1-8T and 1-8 and any further drop in the water level between the two gauges is not continuous.

Gauges in Conservation Area 1 read on May 11, 1970 were as follows: S-5A pump station--14.0, S-6 pump station--15.30, 1-8T--15.35, and 1-8--13.52. All of these gauges with the exception of 1-8T, are located in the peripheral canals. Obviously there are some very striking differences between these readings and the differences suggest that an evaluation of gauge accuracy and location is needed.

An examination of water depths, gauge readings, and averages obtained from readings makes it obvious that the entire system in the Conservation Areas needs a thorough review. The study team recommends that this be done on contract by an independent firm of hydrologic engineers.

It is relevant at this point to comment on the current water regulation schedule for Conservation Area 3. In the opinion of the study team the proposal to lower the schedule in Area 3 by one foot, i.e., from 9.5-10.5' msl to 8.5-9.5' msl, if implemented, could conceivably set up a possible major disaster in south Florida. The present schedule seems to be an appropriate compromise at this time, but it is meaningless unless adhered to.

Rapid extreme fluctuations of water levels are completely at odds with the natural hydroperiod in the Glades. Drastic drawdowns of water levels, or rapid rises, in the Conservation Areas have serious ecological consequences. This was clearly demonstrated in the case of the Everglades kite, one of the endangered North American species, during the latter part of April 1970. Between April 1 and 29 an estimated 46 Everglades

kites were using the Loxahatchee National Wildlife Refuge (Conservation Area 1) and the area adjacent to the L-40 canal on the eastern side of the Refuge. This raptor was nesting on the Refuge for the first time since 1964. A total of 11 active nests was located near the sloughs and along the L-40 canal. Between April 1 and April 29 while the kites were still in the process of nesting, the U. S. Army Corps of Engineers lowered the water level in the L-40 canal from 17.00' msl on April 1 to 13.98' msl on April 29, a difference of 3.02 feet. Personnel of the Loxahatchee National Wildlife Refuge were not consulted prior to the drawdown. The rapid reduction of water levels in the canal dried up most of the sloughs which the kites were using, causing them to leave the Refuge. By April 29 only eight kites were observed on the area and by May 5 only two birds remained. The drawdown also left all known nests over dry ground. Although the drawdown is not known to be directly responsible for the loss of any nests on the Refuge, it seemingly canceled the possibility of further nesting in the Refuge for the remainder of the spring.

When the sloughs go dry the Pomacea snails, which are the sole source of food for the kites, aestivate in the damp mud and are unavailable to the kites. When water again fills the sloughs the snails become active. Rapid dropping of water levels also has deleterious effects on snail reproduction because eggs laid when there is surface water will not survive even if they hatch.

Young kites tend to remain in the vicinity of the nest site from 1 to 3 months after they have fledged. Even if more favorable water levels are restored, the time required for kites to return to the Refuge

in any numbers is unknown. It is the understanding of the study team, however, that population numbers have recently increased in Area 2, and some kites are nesting there.

Seasonal and gradual fluctuating water levels are necessary to perpetuate the integrity of the Everglades ecosystem and have been the usual course of events for a few thousand years. Changes from dry to wet and back to dry again, over short periods of time, however, are completely at odds with the historic hydroperiod and do have very serious and adverse ecological consequences.

In summary, water level regulations for the overall Everglades system must be developed with due consideration for the entire natural resource base. The luxury of unilateral decisions made on the basis of special interest groups can no longer be afforded or tolerated.

It is obvious that there is a need for better communication and coordination between the various agencies involved with the operation of the flood control project and the use and management of the natural resources in the area. The recent rapid drawdown of water levels in the Refuge is an example of this need. Therefore, it is recommended that an interagency coordinating committee be immediately appointed to provide a mechanism for interaction and information exchange between the various agencies and groups involved with the natural resources in the Everglades.

One very perplexing problem in the Everglades is the capability of the flood control project to comply with water regulation schedules during drought and very wet periods. During dry periods, for example, there is an inadequate supply of water for most purposes and during wet years

there is too much. This is not only the case in the Conservation Areas but also applies to the surrounding agricultural lands and Everglades National Park. Thus, during very wet periods the problem is where to put excess water in order to bring levels down to schedule in the Conservation Areas. When there is too much water in the Conservation Areas there is also too much elsewhere in the region. Water removed from Conservation Area 3, for example, must either be discharged through the Park or out the canals to the east coast. The rapid influx of water into the Park can cause problems there and an excess of fresh water in the east coast estuarine environment can have deleterious ecological effects in these locations.

Thus, one of the key factors in the preservation of the Everglades environment is the restoration, insofar as possible, of some semblance of the natural hydroperiod. Shifts in the ecosystem away from its original condition will undoubtedly be in direct proportion to the degree that man attempts to manipulate the water in a manner that significantly departs from natural hydrological conditions.

Not only is the Everglades ecosystem, and the human population residing in the area around the Everglades, dependent upon an adequate amount of water but they are also dependent upon water of good quality. In the upper Kissimmee lakes, for example, a problem of over-enrichment of the water is rapidly developing. This condition results from the input of sewage, chemical fertilizers, and other contaminants coupled with sharp reductions in water level fluctuation as a consequence of flood control activities. In Florida, over-enrichment of the water typically

causes a shift in plants from submerged to emergent species, including increased growth of water hyacinths, growths of great quantities of algae, and shifts in fish species from desirable to undesirable ones.

The broad marshes of the lower Kissimmee River have been greatly reduced by channelization. This has essentially obliterated the capability of the former marsh to absorb nutrients from the water and is speeding the eutrophication of Lake Okeechobee. Sewage, fertilizer, and other waste entering from around the Lake are further compounding the problem.

Whereas the old Kissimmee marshes reduced the flow of water to Okeechobee, the new channel moves it there rapidly, carrying great quantities of mud and pollutants into the Lake. In addition to the mud and nutrient load now carried down the Kissimmee "ditch" into Lake Okeechobee, these waters also contain pesticides and other contaminants which may now be getting into the Conservation Areas and Everglades National Park. Furthermore, oil exploration in the region and the possibility of oil leaks from pipelines which cross Area 3 pose a serious potential threat not only to water quality in the Glades but to the entire ecosystem.

Although it has been alleged that nothing that goes on in the Kissimmee River-Lake Okeechobee part of the system has any influence on the area south of the Lake, there seems to be good reason to question this view. Back pumping from agricultural lands into the Lake, intensive cattle operations on the Taylor Creek drainage, stabilization of levels in the headwater lakes, and channelization of the Kissimmee River are obviously contributing to the buildup of nutrients, pesticides, and other

contaminants in Lake Okeechobee and in the Everglades itself. If one of the reasons for increasing the storage in Lake Okeechobee by raising the levee is to provide more water for commercial uses and the Park via the Conservation Areas, the quality of the Lake water becomes of real concern.

Although it is apparently intended that the main discharge from Okeechobee in times of high water will be to the Atlantic Ocean and the Gulf through the St. Lucie Canal and Caloosahatchee River, there is a strong possibility that eventual water shortages and ecological damage to the estuarine environments in the vicinity of the freshwater outflow may force a decision to divert a greater proportion of the discharge to the south through existing or additional structures. The resultant changes in the quality of water, as well as the amount and timing of water discharged into the Everglades, will probably be reflected in additional plant and animal changes. It is therefore imperative that the quality of the water in the Everglades ecosystem be continually monitored and that steps be taken to maintain high water quality standards.

The U. S. Geological Survey is now engaged in a water quality study primarily in Everglades National Park, the Loxahatchee National Wildlife Refuge, and Lake Okeechobee. They have instituted a rather extensive water sampling network and are monitoring levels of chlorinated hydrocarbons, polychlorinated biphenyls, heavy metals, and other contaminants. This is a good beginning, but the survey should be extended to cover the Kissimmee Valley and Conservation Areas 2 and 3, and in all appropriate locations plant and animal indicator species should also be monitored.

VEGETATION

Limitations of time and space have not permitted a detailed evaluation of the vegetative communities in the Everglades or changes in them resulting from water level manipulations and other factors. Although a detailed report will be prepared later by Loveless, a few brief comments are relevant.

The principal vegetational components of the Conservation Areas are the sawgrass, wet prairie, slough aquatic, and tree island communities. Detailed descriptions of these various communities and their respective community types appear in various available publications and reports.

Dramatic changes in the original vegetative matrix have occurred in the Conservation Areas, particularly Areas 1 and 2. Although intense, widespread fire during drought periods has undoubtedly contributed to these changes, the overriding cause has been alteration of the historic hydroperiod.

Such alterations in the hydroperiod have essentially eliminated the tree island communities and the once extensive whitegrass (Rhynchospora spp.) flats in Conservation Area 2. Also, the willow-myrtle "thickets," once widespread in the northern portion of Area 2, now no longer exist. A few other formerly abundant species that are either now uncommon or rare include primrose willow, groundsel bush, wax myrtle, red bay, red maple, and two species of beak rushes. These changes have been accompanied by an increase in the slough aquatic communities and their component species (white waterlily, spike rushes, flag, and submerged aquatics), an apparent increase in the density of sawgrass in some areas, extensive

invasions of cattail in certain locations, and the reversion of areas formerly dominated by emergent vegetation to essentially open water with abundant submerged plants.

Changes of the types described in the foregoing are taking place to some extent in all of the Conservation Areas. They are most apparent in Conservation Areas 1 and 2 and less so in Conservation Area 3. In general, the region north of Alligator Alley in Area 3 and pool 2B in Conservation Area 2 appears to have undergone the least vegetative change of any locations in the Conservation Areas.

DEER SITUATION

Deer, from the earliest times, have been a part of the native fauna of the Everglades. Declines in their numbers during times of high water and buildups in numbers during dry periods have undoubtedly always occurred. Periodic fluctuations of animal population numbers in response to environmental conditions are the usual pattern with most species, and Everglades deer are no exception.

In the past few years there has been a decline in the numbers of white-tailed deer in the Conservation Areas. High water levels maintained over relatively long periods have essentially eliminated deer from Conservation Area 2 and few have been reported since 1966. This area formerly supported a rather sizable population. Also, only a few deer remain in the north end of Conservation Area 1. Conservation Area 3, particularly the area north of Alligator Alley, is the last remaining "stronghold" of a once relatively abundant deer herd in the Conservation Areas.

Physical well-being of Everglades deer usually declines with the advent of high water levels in late summer and fall but improves as depths recede during the dry winter and spring months. This is directly related to the abundance, availability, and nutritive quality of forage, and the density of the herd itself. As water levels in the marsh increase and approach depths exceeding about 2 feet the majority of the deer congregate on elevated sites. Their activities are confined primarily to these restrictive high-ground areas until depths drop below approximately 2 feet. With the decline in water levels the deer begin to use the open marsh more and more in response to the availability of abundant natural food. By the time fawns are dropped in the spring the herd is usually in good physical condition. If water levels of more than about 2 feet persist for extended periods, however, as they did in 1947, 1953, 1957, 1958, 1966, and 1968, conditions can become critical and mortality occurs, particularly among fawns, yearlings, and does. Such mortality is related not only to reduction of available forage and resting sites but also to the density of the herd.

During prolonged high water stages when deer become crowded on elevated sites and severe intraspecific competition for forage ensues, they suffer a subsequent decline in general physical condition and there is increased susceptibility to parasitism and disease. In some instances heavy parasitic infection or disease incidence undoubtedly contributes to mortality or otherwise reduces survival probability, but malnutrition and associated fatigue are the basic causes leading to death.

Fawns in the Everglades are dropped throughout the year, but a definite peak occurs during March and April when about 60 percent of the births occur. During spring, the Everglades is usually dry except for water retained in alligator holes, canals, and the deeper sloughs; and an abundance of forage is available. Also, fawning sites are more than adequate. This contrasts sharply with the condition that exists during unusually wet years when high water persists through the normally dry spring months and suitable forage and fawning areas are limited to the elevated tree island and levee sites. A considerable reduction in fawn survival can occur under such conditions. Thus, population numbers of deer in the Everglades vary from year to year depending largely on the amount of seasonal rainfall and resulting water levels which in turn determine the amount of available nutritious forage and fawning and resting sites. Populations have increased during dry periods and decreased during wet periods since time immemorial and such is the natural course of events. These fluctuations in numbers, however, represent a response that has evolved with "natural" hydroperiods and although some mortality can always be expected during unusually wet periods, the magnitude and extent of the mortality will be largely dependent upon the degree of departure from historic hydroperiods and the density of the population itself.

When water depths in the Glades are in excess of 2 feet and persist for extended periods, mortality and stress to deer occur. These conditions produce adverse effects if they occur during the spring fawning months, as in March 1970. Regardless of the time of year high water

levels occur, however, the herd responds by moving to elevated locations. If high water persists for about 6 weeks or longer, malnutrition becomes evident as available high-ground areas are reduced and nutritious forage is exhausted. For optimum deer management under fluctuating hydroperiods in the Everglades, water depths over important sections of the range should not exceed approximately 2 feet for much longer than about 6 weeks at a time, and during the spring fawning period for not more than about 3 to 4 weeks. By the end of February, most of this range should be reasonably dry, 6 to 8 inches or less, in order that adequate fawning sites will be available. This was not the case in Conservation Area 3 or apparently in the Park during much of March 1970.

It is relevant at this point to briefly review the history of deer population numbers in the Glades over the past 12 to 14 years.

Following the high mortality experienced in 1957 and 1958, deer numbers in the Conservation Areas gradually increased and probably reached a peak sometime in 1964. Heavy rains, beginning in July 1966, resulted in excessive water depths and by August of that year mortality was taking place. During this period the few deer remaining in Conservation Area 2 were essentially eliminated.

In 1967 no unusually high water occurred and in the spring of that year there was apparently good survival of fawns. In 1968, however, high water levels were again experienced beginning about mid-September, and Conservation Area 3 was closed to access. During this period the Florida Game and Fresh Water Fish Commission estimated that approximately 800 deer died in the area, primarily as a consequence of the high water. In

July 1969, another period of high water occurred and there was some mortality of fawns and yearlings. Although this mortality continued to occur through the winter period it was estimated that by November, 70 percent of the 1969 fawn crop had been lost.

During March 1970, approximately 11 inches of rainfall was recorded in the Conservation Areas resulting in high water levels. Personnel of the Florida Game and Fresh Water Fish Commission estimated that such levels resulted in a fawn loss of about 20 percent.

The inspection by the study team of Conservation Area 3 on April 7, primarily north of Alligator Alley, indicated that at the time much of the mortality due to high water had essentially diminished, but it was considered that if high water persisted, or levels increased, additional mortality would occur. It was clear, however, that there had been prior stress to the herd. Browse sign on the vegetation and the seemingly good physical condition of the deer that were observed (about 12 to 15 animals) suggested that the immediate situation was not as severe as during the high waters of 1957-58, 1966, and 1968.

In 1957-58 and 1966, as a consequence of high water causing deer to concentrate on high-ground areas, there was great evidence of heavy browsing on these sites. On most of the tree islands all the vegetation was completely removed and the bark on the trees was eaten up as high as the deer could reach. Soil on the islands was bare, trampled in many instances into mud by both deer and hogs. During 1957-58 and 1966, it was possible to walk up to many deer on the tree islands and actually touch them. It was obvious that they were extremely lethargic and

fatigued and suffering from malnutrition. Such severe conditions were not evident during the visit by the team to Conservation Area 3 north of the Alley in March of 1970. Nonetheless, we believe that the high water in March 1970 did result in some stress to the deer, but the severity of the effects was less than in 1957-58, 1966, and 1968.

At the time of the team's inspection, water conditions in Conservation Area 3 were on the "ragged edge" of being a dire threat to the remaining herd. If water levels persisted or continued to rise it was believed that loss of deer proportionally as great as in 1966 would occur.

In summary, the deer population in the Florida Everglades has decreased markedly over the past few years. Irrespective of the reliability of periodic censuses that have been made and the magnitude of losses that have occurred periodically over the years due to high water, it is apparent to anyone who has had any long-term familiarity with the area that significant declines have occurred. Furthermore, there is little question that these declines have been primarily a consequence of unusually high water levels of prolonged duration. An important secondary factor is the human disturbance of fatigued deer already stressed by high water.

It is unlikely that stress to deer can ever be completely eliminated under all conditions, but it should be recognized that if the frequency and duration of abnormally high water levels are substantially increased beyond those occurring in the historic past, the stage will be set for elimination of deer from the interior of the Everglades marsh.

Various management procedures could be used to alleviate some of the deer problems in the Everglades. For example, the Florida Game and Fresh Water Fish Commission should be more flexible in setting hunting regulations and be more effective in controlling the harvest of deer and the human disturbance factor. When high water conditions and impending stress and mortality to the herd are anticipated, assuming that population numbers are not so critically low that hunting would be irrevocably detrimental, an early opening of the season would have the advantage of utilizing animals destined to die from stress and reduce the herd to levels better adjusted to the limited carrying capacity of the area in flood.

Harvest should be essentially controlled by permit hunts, e.g., a given number of permits issued to attain a desired level of harvest. Because of ease of access to the area and other related problems, it is doubtful if effective control of the harvest can ever be regulated in any other manner.

Permit hunts to obtain desired levels of harvest of big game animals have been quite effective in many parts of the country and they are generally well accepted by sportsmen once the objectives are understood. Such hunts are usually handled somewhat as follows:

Interested sportsmen file an application in late spring or summer prior to the hunting season. The license fee is submitted at the time they file. Game agency personnel recommend what the total desirable harvest should be and sufficient permits are issued to approximate this as nearly as possible. If the number of applicants exceeds the number

of permits to be issued, a random drawing is held. License fees are returned to unsuccessful applicants. A tag and questionnaire should be attached to the license permit, the tag to be placed on the animal immediately after it is killed and the questionnaire to be returned to the game agency by all permittees within 10 days following the close of the season. The questionnaire enables the agency to evaluate the effectiveness of the hunt and provides other valuable management information. Implementation of such hunts costs money, and this cost should be included in the license fee.

The Game Commission should act with boldness and imagination in managing the Everglades deer herd. They should immediately initiate an intensive research investigation, and should insist that those agencies responsible for water level management in the area give due consideration to this valuable resource. A compromise that could be considered is to manage the area north of Alligator Alley with deer as the primary resource.

Other matters related to deer and deer management in the Glades involve use of airboats and halftracks, camps on islands, use of dogs, and habitat manipulation.

Use of halftracks should be prohibited or at least be rigidly controlled and regulated in the Conservation Areas. In the latter case, it would be advisable to restrict their operation to certain authorized trails or locations. There is evidence that these large and rather efficient machines have severely damaged some of the tree island strands by running back and forth through them, and have otherwise altered other

characteristic components of the environment. In any event, strict regulations on their use in the area is imperative.

Airboats in general seem to be somewhat less destructive of the habitat but because of the continuing increase in their numbers in the Everglades, serious consideration should be given to tighter regulations governing their use, particularly for hunting deer. The desirability of restricting their use to authorized trails or locations in the Conservation Areas should also be evaluated.

Use of dogs for hunting deer in the Everglades should be prohibited.

Permanent camp structures located on tree islands in Area 3 occupy space that could otherwise be producing forage and providing undisturbed high-ground areas for deer during high water periods. In addition to the actual physical space occupied by the camp structure, the native vegetation has frequently been replaced by lawn grass planted in the form of sod around many of them. Although deer may on occasion eat this grass, it is questionable that the nutritional quality of such forage is as good as the native vegetation preferred by deer. In addition, the camps in both Areas 2 and 3 constitute a source of pollution, particularly those built over the water, and many have a generally ramshackle appearance which clearly detracts from the aesthetics of the area. Furthermore, the legality of private individuals building permanent structures on public land is highly questionable to say the least.

The study team is not opposed to optimum but compatible recreational use of the Conservation Areas, including temporary tent camping, and in fact urges that such opportunity and privilege be assiduously preserved

and encouraged. However, the maintenance of permanent camp structures in the Conservation Areas, or the proliferation of new ones, is contrary to the precepts of acceptable and proper use of the public domain. The agencies responsible for permitting this situation to persist essentially unchanged over the years have, in the opinion of the study team, neglected their obligations to administer and manage these lands in the best interests of those who own it--all the people.

The Game Commission is responsible for issuing annual permits at no charge for permanent camps in Conservation Areas 2 and 3. To date, 30 permits have been issued for Area 2, and 33 for Area 3. Also, other additional camps are located in the Areas for which no permits have been issued. The entire question of these permanent camps is complex from both a legal and public relations standpoint. The study team believes that they should be ultimately removed from the Conservation Areas but recognizes the difficulties involved in such action. We urge, however, that the proliferation of new permanent camps be strongly resisted, and that the legal status of all current permanent camps, particularly those alleged to be on private lands, be resolved as well as the jurisdictional authority of the State. As a measure to eventually eliminate all permanent camps from the Conservation Areas we recommend that the camps now on public land, where state agencies have jurisdiction, at the very least be allowed to exist only during the lifetime of the adult owner to whom the permit has been issued. Furthermore, we recommend that strict regulations be formulated and enforced relative to the size of clearings surrounding these camps and for the disposal of refuse and other waste products.

Although the team recognizes that artificial islands can be of some benefit to deer, they are by no means the solution to the basic problem of prolonged high water periods in the Everglades. Whether to construct these islands is a decision which must be made by the agencies involved. If the decision is made to construct islands, we recommend that they be limited to the area north of Alligator Alley and to four or five per square mile, that they be one-eighth to one-quarter acre, elliptical in shape, and oriented generally north-south.

If the islands are to serve a useful purpose for deer they should not only provide refuge during high water but also food. We believe that if they are properly constructed with an adequate layer of muck soil on top, native vegetation will invade the sites and provide forage. In our view the money now being used to construct artificial islands would be better spent by placing an 8- to 10-inch muck layer on the spoil banks along the new Miami Canal in Conservation Area 3.

During high water periods there have been efforts to capture deer for removal to other areas, or to "nurse" them back to health. From a humanitarian standpoint there is certainly nothing remiss in picking up an animal in the Glades--providing it is legal to do so--that is obviously in very poor physical condition. However, efforts to capture deer during high water periods by running them down with airboats, or other means, increase the stress on the animals and cause more harm than good.

FROGS

Bullfrogs are an important economic and recreational resource in the Everglades. Also, in the total ecology of the Glades this species is an

important link in many food chains. Based on available information, and as predicted in the Conservation Area 3 report prepared by the Florida Game and Fresh Water Fish Commission in 1960, the overall flood control project has been substantially beneficial to bullfrogs. A research effort should be initiated, however, to continually monitor the status of this resource and manage it effectively.

FISH

Of all the important natural resources in the Conservation Areas, fish furnish the most recreation to the largest number of people and probably make the greatest contribution to the local economy. It is obvious that the overall flood control project has indirectly benefited this resource through the borrow pits that have resulted from construction activities in the Conservation Areas.

Although prolonged high water levels benefit the fish resource, it is only one consideration in the overall water management program for the Conservation Areas. Numerous other important natural resources exist in the Everglades and must necessarily be given due consideration. Continuing research is necessary, however.

ALLIGATORS

Alligators are an integral part of the ecology of the Florida Everglades and during earlier times were very abundant. Man's activities in the area, however, have had a significant adverse impact on population numbers.

When water levels in the marsh recede during dry periods, alligators either retreat to the canals or into so-called 'gator holes. Use of these holes by alligators usually keeps them free of vegetation, but willow, myrtle, holly, and other woody shrubs ordinarily grow around the periphery. A den or cave is generally associated with the hole and extends from the edge 10 to 15 feet beneath the roots of the surrounding trees. During severe drought, alligators remain in the caves as the water recedes because they frequently retain water for many weeks after the surrounding marsh has dried up.

Alligator holes are important as aquatic reservoirs during droughts and furnish not only food for wading birds but provide a nucleus of aquatic organisms that help repopulate the marsh when the water again rises. Willows and other vegetation that form the periphery of these holes are also a source of food and cover for many species of vertebrates, especially breeding birds.

When drought periods are prolonged there is an obvious heavy mortality of young alligators because they concentrate in these holes and are thus exposed to heavy predation. Another source of alligator mortality is due to rapidly rising water levels during late spring and early summer that inundate nests and destroy them. The nests of turtles and certain species of water snakes can also be destroyed by rapidly rising water levels.

Records of inventories of alligator populations and general impressions of people currently familiar with the Everglades suggest that there has been a drastic decline in numbers over the past 15 years. Populations in the Loxahatchee National Wildlife Refuge may be an exception to this.

Evidence of a general decline in alligator numbers in the Everglades is provided by aerial count records from 1954 through 1968. In the early 1950's aerial alligator counts were made along the old Miami Canal in the northern portion of Conservation Area 3. Part of this flight line, 15-1/2 miles, was along the canal north of Conservation Area 3, and another part, 24 miles long, covered the canal in Conservation Area 3. The 24-mile portion of the canal within Conservation Area 3 showed 2.6 alligators per mile on March 22, 1954. The 15-mile section north of Conservation Area 3 showed 6.0 alligators per mile. On April 5, 1965, 11 years later, the 24-mile section of the canal averaged only 0.88 animal per mile. On April 12, 1968, 1.6 alligators per mile were seen. The portion of the canal located inside the Conservation Area is still quite similar to that present when the transects were flown in 1954.

Counts made along the Alligator Alley borrow pits by boat have also shown a decline over the past few years. For example, in April 1967, 174 alligators were counted. Since then there has been a steady decline in numbers counted along this transect as evidenced by counts in June 1968 which showed only 27 alligators. Comparable counts along the L-39 canal showed 149 in May 1967 as contrasted with 74 in June 1968.

Available information also shows that some loss of alligator habitat has occurred. Perhaps the best example is the area north of Conservation Area 3 that as late as 1954 harbored an impressive number of alligators. Habitat for alligators in this area has now been virtually destroyed due to agricultural development and accompanying drainage. Habitat destruction

has also been caused by increased demands for housing in locations adjacent to the Everglades, resulting in drainage of marsh areas.

Drainage projects in south Florida have created literally hundreds of miles of canals. Creation of stable open water in the canals would seemingly benefit alligators, particularly during dry periods. However, benefits which may have occurred from these increased reservoirs of deep stable water probably have been offset by making alligators considerably more vulnerable to poaching. Furthermore, deterioration of water quality in the canals may be reducing alligator food populations.

In the past 15 or 20 years hunting pressure has increased as a result of more people, development of the airboat, and the digging of additional canals. These developments have coincided with an increase in demand for hides which has resulted in tremendous pressure on alligator populations.

In summary, the drainage of areas adjacent to the Conservation Areas has destroyed or altered much alligator habitat. Furthermore, interference with natural water level fluctuations creates an abnormal drought and flood phenomenon. This phenomenon significantly affects the productivity of alligators by increasing mortality to juveniles during severe droughts and loss of nests to flooding during periods of rapidly rising water levels. Thus, evidence suggests that the decline in the numbers of alligators in the Everglades is due principally to excessive illegal hunting and to man's altering or destroying the habitat.

RECREATIONAL USE

There are few places in this country where such a vast natural area as the Everglades is located so close to large urban population centers. Extensive and diversified recreational uses of the area are now taking place and these uses can be expected to increase substantially in the near future.

Outdoor recreational uses of the Conservation Areas should be subject to careful and continued evaluation. This is important now and will continue to be important in the future. As use by people increases it may become necessary, for example, to strongly regulate and control certain types of activities that damage or alter the ecology of the area. Planning must necessarily consider such things as airboats and half-tracks; massive habitat manipulations; permanent camps; major activities such as construction of new canals, causeways, deer islands, or other engineering structures; and must take into account both consumptive and nonconsumptive uses.

A well coordinated, comprehensive outdoor recreational plan does not now exist for the Everglades. Certain plans which have been developed by the various agencies are commendable but in the view of the study team they do not go far enough. There also seems to be some confusion among the agencies involved concerning responsibility for overall recreational planning and development in the area.

Therefore, we recommend that a comprehensive recreational plan be developed. It should consider, insofar as possible, all aspects of the natural resource base existing in the Everglades, including the commercial

uses of water, and should provide for the balanced use of the resources and the development of adequate but compatible public recreational facilities and interpretative programs. Such planning lends itself rather well to a systems approach, and considerable assistance could be obtained through contract with private firms.

CONCLUSIONS

The freshwater marsh that is the Florida Everglades is a dynamic, fluctuating water level ecosystem. Historic fluctuating levels have created the Glades and essentially maintained it in an intermediate successional developmental stage. Man's activity in the area has interrupted the natural process and by so doing produced a simpler and less diversified biological system than was present even a decade ago. There has been a decline in numbers, or a shift in distribution, or both, of turtles, water snakes, and alligators, as well as some species of mammals and colonial nesting and wading birds. There has been an increase, however, in the numbers of fish, and seemingly in the numbers of frogs, limpkins, some species of waterfowl, and probably a few aquatic invertebrates. Associated with these faunal changes has been a sharp reduction in the diversity of plant species which comprise the major communities.

Seasonally fluctuating water levels in the Glades provide a mechanism for rapid nutrient cycling. For example, during dry periods the aerobic decomposition of accumulated organic matter causes release of nutrients (fire that often occurs during droughts also releases large amounts of nutrients) and when water levels rise during the rainy season,

the productivity of the marsh is again renewed. The life cycles of the many indigenous plants and animals in the Glades are intimately and inexorably tied to this periodicity. Thus, alteration of the historic and ancient hydroperiod, particularly if it manifests itself in the form of more or less prolonged stabilized water levels, will have a severe impact on the Everglades ecosystem and essentially destroy it as it has existed in the past. This will occur as surely as if current plans called for complete drainage.

The vast man-made reservoirs in south Florida have solved some problems while creating a host of others. The time has now arrived, however, when the decision must be made as to what we really want the Everglades to be--it obviously cannot be all things to all people because conflicts will inevitably arise. There must be compromise. The issues are not limited to just whether agricultural lands are flooded or not flooded, or to aesthetics, or to full creel and bag limits; it is the existence of a viable, dynamic, and significant natural area. Man now has the capability, through his technology and sheer numbers, to drastically alter or ultimately destroy the Everglades. He also can preserve it, and if this cannot be done on the sole basis that it is a great natural area of unique national significance, then there seems to be little justification for preserving any other large unique natural area in this country.

The Florida Everglades has had tremendous demands placed upon its resources. The greatest pressure for use of these resources has originated with the economic sector of society and as a consequence many

decisions in the past have been made on this basis and on the basis of engineering considerations. Unquestionably, great monetary benefits have resulted and we do not mean to imply that those decisions have all been necessarily wrong. It is imperative, however, that overall objectives for the Everglades be reevaluated. Now is obviously the time to make some new decisions.

We recognize that the agencies responsible for management of the resources in the Everglades must face the hard reality of everyday problems and pressures. Because of their obligations, both legal and moral, they must necessarily respond with hard practical solutions and action programs and often with inadequate knowledge. In so doing, however, it has become increasingly important that they look beyond the expediency of satisfying immediate public demands and gear resource management programs to the total natural resource base. Currently in this country there is widespread public concern for maintenance of environmental quality. Many now recognize that the value base of pure economics and cost-benefit ratios will have a hollow ring if there are, for example, inadequate supplies of good water, good air, or reasonably extensive natural areas of high quality.

While those involved with the Everglades are preoccupied in endless controversy, hurling accusations back and forth, questioning the reliability of information and the integrity of actions, the Everglades ecosystem as we know it is literally going down the drain. Man has played Russian roulette with the Glades for a very long time. One day soon he may pull the trigger on a loaded chamber.

A. General

1. An interagency coordinating committee should be immediately established. It should be composed of the heads, or their representatives of the county, state, and federal agencies involved with use, management, or investigation of the resources in the Everglades and initially should include local county groups, the Central and Southern Florida Flood Control District, Florida Game and Fresh Water Fish Commission, Florida Department of Natural Resources, Florida Air and Water Pollution Control Commission, Everglades National Park [redacted], U. S. Army Corps of Engineers, U. S. Geological Survey, U. S. Bureau of Sport Fisheries and Wildlife, Bureau of Indian Affairs, the Federal Water Quality Administration, and one citizen-conservationist from south Florida and one independent environmental scientist, both to be appointed by the Governor. The purpose of the committee would be essentially to provide a formal mechanism for interaction and information exchange on both day-to-day and long-term operations and plans. It is absolutely imperative that there be a complete and free exchange of information between the agencies and organizations concerned. If this cannot be accomplished on a "gentlemen's agreement" basis through the mechanism of a coordinating committee, then appropriate legislation should be passed requiring it. The situation in the Everglades is so

critical that the luxury of unilateral decisions made by one agency or group that affect the interests of all others cannot be afforded or tolerated.

2. An interagency cooperative research program should be immediately implemented in the Everglades. Investigations should be undertaken as a coordinated team effort by both state and federal agencies and by qualified private organizations and individuals as appropriate. Such investigations should be far-reaching and comprehensive and include all aspects of the Everglades environment, viz., ecological, sociological, and economic. Foremost should be achievement of the combined goal of preserving the Everglades, insofar as possible, as a unique natural area of national and international significance, and maintenance of potable water supplies, the quality of the environment, and the economic viability of the region. A critical evaluation of the programs and project plans of the U. S. Army Corps of Engineers and the Central and Southern Florida Flood Control District must be included as a major thrust of such investigations.

3. There is a growing consensus that the on-going channelization of the Kissimmee River was an ecological disaster. The study team recommends a cessation of its construction and a bio-engineering study of the feasibility of diverting flood waters pouring down the "ditch" into the broad, lateral river marshes, thereby slowing flow and improving water quality. Efforts to restore the natural hydroperiod of the Everglades must begin in the Kissimmee Valley.

4. Publicity releases and press coverage concerning crisis situations or conditions in the Everglades should be cleared by the agency heads involved and to be most effective must emphasize the basic causes rather than just the symptoms. Reporters, officials, biologists, engineers, and administrators alike must refrain from the "isolated phenomenon" syndrome and emphasize the problem in its total context as related to the entire Everglades problem. Society must be factually informed about the overall problems and their causes.

B. Water Quantity and Quality

1. Water regulation schedules for the Conservation Areas should be completely reevaluated to determine their applicability in terms of current or new priorities and objectives. Such reevaluations should be a continuous process. When schedules are established they should be adhered to as closely as possible.

2. The accuracy and location of the water level gauges in the Conservation Areas should be reevaluated by an independent group of hydrologic engineers. The entire gauging system and how water level records are used as guidelines to regulation schedules need thorough review.

3. One of the principal objectives of water management in south Florida should be to restore and preserve as closely as possible the historic natural hydroperiod, and water level regulation for the overall Everglades system must be developed with due consideration for the entire natural resource base. Seasonal and

gradually fluctuating water levels are necessary to perpetuate the integrity of the Everglades ecosystem but rapid changes in water levels over short periods of time have adverse ecological consequences and should be avoided by the managing agencies if at all possible.

4. Every effort should be made to ensure that Everglades National Park continues to receive an adequate supply of quality water on a proper seasonal basis to maintain the natural integrity of the flora and fauna of this unique and internationally significant area.

5. Water quality in the entire Everglades system should be continually monitored for nitrates and phosphates, chlorinated hydrocarbons, polychlorinated biphenyls, heavy metals, and other contaminants, and the sources of each determined. The sampling network should include the Kissimmee Valley, Lake Okeechobee, Everglades National Park, and the three Conservation Areas. At all appropriate locations plant and animal indicator species should also be sampled and analyzed.

C. Vegetation

1. It is essential that long-range, intensive studies of the vegetation in the Everglades be undertaken on a continuous basis in order to document changes due to water levels or other factors.

D. Wildlife

1. Deer

The Florida Game and Fresh Water Fish Commission should immediately initiate a comprehensive research program on the Everglades deer herd. Such research should emphasize the population dynamics of the herd, deer movements, disease, and nutrition, and the relationships between herd density, water levels, the carrying capacity of the habitat, and man's activities in the area.

The Commission should act with boldness and imagination in managing the Everglades deer herd, and in particular should be more flexible in setting hunting regulations to more effectively control the harvest of deer in relation to carrying capacity, and be more effective in minimizing human disturbance during stress periods. Consideration should be given to managing the area north of Alligator Alley in Conservation Area 3 with deer as the primary resource. Agencies responsible for water level management in the area should give due consideration to the welfare of the deer herd.

2. Frogs, fishes, alligators, waterfowl, and colonial nesting and wading birds

The status of these valuable resources and their habitats should be continually monitored through extensive long-term research.

E. Recreational Use

1. A comprehensive far-reaching recreational plan should be developed for Conservation Areas 2 and 3. Such a plan should consider, insofar as possible, all aspects of the natural resource base, including the commercial uses of water, and should provide for balanced and compatible use of the resources and development of adequate public facilities and interpretative programs.

F. Other

1. Use of halftracks in the Conservation Areas should be eliminated or at least rigidly controlled and regulated. If permitted, their operation should be restricted to specified trails or locations, or both.
2. Consideration should be given to more rigid regulations governing the use of airboats in the Conservation Areas, particularly during periods of high water and for hunting deer.
3. Use of dogs for hunting deer in the Conservation Areas should be immediately prohibited.
4. All permanent camps located in the Conservation Areas should be eventually eliminated and strict regulations established to minimize any deleterious effects on the environment while they are in existence.
5. If artificial tree islands are constructed in Conservation Area 3, they should be confined to the region north of Alligator Alley, should be 1/8 to 1/4 acre, appropriately spaced and not exceed four or five per acre, and should be elliptical in shape with

their long axes oriented generally north-south. An 8- to 10-inch muck layer should be placed on the spoil banks along the new Miami Canal in Conservation Area 3 to encourage the invasion and growth of native vegetation.

6. The State of Florida should give serious consideration to acquiring all private lands in the Conservation Areas. This would provide needed jurisdictional authority for better control and management of the resources in the area.

7. Public acquisition of sufficient portions of the Big Cypress Swamp should be pursued to protect its water resources and wildlife.

8. Alternative courses of action, e.g., wild or primitive area status, etc., should be evaluated as a measure to protect the unique flora and fauna of all or portions of Conservation Area 3.